

Original citation:

Coakley, Mathew. (2017) Hempel, Grue and the logical empiricist baseline. Erkenntnis .

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Publisher's statement:

The final publication is available at Springer via <http://dx.doi.org/10.1007/s10670-017-9922-2>

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Hempel, Grue and the Logical Empiricist Baseline

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*Pre-publication copy – please only quote from published version
at Erkenntnis doi:10.1007/s10670-017-9922-2*

Abstract

A logical empiricist “baseline statement” can formalize some propositions established by a body of evidence or set of observations. However, it may not necessarily capture, of two propositions it entails, whether all the subsets of the evidence that establish one proposition also establish the other, vice versa, or neither. Yet, according to this paper, which obtains should sometimes matter for confirmation. It illustrates by showing how this “evidential dependence” can be used to address problems with generalizations of grue-like predicates, and do so still within a very simple broadly Hempelian framework.

1 Introduction

Hempelian logical empiricist confirmation - as at Hempel 1945, 1965 - has three components:

- (1) An “empiricist baseline” which is a statement or formal description of what we might (or do) know about what exists and some of its properties (and perhaps, in certain situations, of what does not exist).
- (2) A statement of a hypothesis or several hypotheses (“H”).
- (3) A condition or set of conditions identifying which logical relations should hold between the empiricist baseline and H such that H is confirmed or disconfirmed.

Hempel’s favoured version of the empiricist baseline was an “observation report” referencing a specific object and some of its properties (or a series of such reports, an “observation statement”), though he was decidedly non-dogmatic about this (1965, 22-23). A common alternative is simply for this to be a statement of what the evidence establishes about what exists, the difference being between “a is a cow and a is black” and “There exists a black cow”. All the arguments of this paper will apply equally to either formulation, and for concision I will typically illustrate with the latter, but one

could trivially convert all such statements to those indexed on particular objects. The general term “empiricist baseline” is used as a placeholder covering either formulation.

The core thesis of this paper is that that *some* of the problems the overall approach has faced – notably those associated with Goodman’s New Riddle – are not, as is typically assumed, due to (3) but instead due to (1)¹. Specifically, the problem is that if a set of evidence establishes a particular empiricist baseline that itself entails “P” and entails “Q” then it is possible this baseline will not identify whether all sub-sets of the extant evidence that establish P also establish Q, vice versa, or neither. Confirmation, though, should sometimes be contingent on which obtains.

Having set out the central idea, the paper illustrates with the grue paradox. It argues that the paradox is a problem for formal confirmation principles *precisely because of a failure to capture these sorts of facts about evidential dependence* in a standard empiricist baseline. We can however remedy this. Doing so identifies why a green emerald observed before some future time T should not normally confirm hypotheses asserting grue-like generalizations.

More broadly, the solution is robust to the multiple versions of grue. It does not require assuming a particular predicate pair – green/blue vs grue/bleen – is primitive or privileged, nor that one is better entrenched (Goodman 1955), a natural kind (Quine 1970) or genuine as opposed to “pseudo” (Shoemaker 1980, Bealer 1982, Armstrong 1985). In addition, the solution can address proposed problematic “emerose” style predicates (Godfrey-Smith 2003), and it enjoys advantages over the rival counterfactual approaches developed following Jackson (1975, Jackson & Pargetter 1980).

2 The empiricist baseline and evidential dependence: a very brief illustration

According to Hempel (1965, p22)

“An *observation report* will be construed as a finite class (or a conjunction of a finite number) of observation sentences; and an observation sentence as a sentence which either asserts or denies that a given object has a certain observable property (e.g. ‘a is a raven’, ‘d is not black’), or that a given sequence of objects stand in a certain observable relation (e.g. ‘a is between b and c’).”

The entailments of such a statement are then – via the overall approach – used to identify which hypotheses are confirmed or disconfirmed by a confirmation condition. The difficulty I want to explore is that such an empiricist baseline statement will not

¹ The core tool of this paper – evidential dependence – has no special resources, for example, to say anything new about the ravens’ paradox. It really is only one subset of the challenges that are addressed.

necessarily identify whether one entailment is established – that is we accept it – solely due to subsets of the overall evidence all of which establish another entailment or not. This “evidential dependence” can be roughly intuitively illustrated with the difference between the following scenarios (where an object is “a piece of steak-cutlery” if it is a knife or a fork but not if it is a spoon):

1. You look in your top-drawer and see a knife and then see a spoon.
2. You look in your bottom-drawer and see a knife and then see a fork.

In both scenarios we have evidence of what the respective drawer contains and could formally describe this with an observation statement; for instance, with reference to the top-drawer, “There exists a knife and there exists a spoon”, or “object a exists and a is a knife; object b exists and b is a spoon”². Our description of each scenario will both individually entail (with reference to the specific drawer) that “There exists a piece of steak-cutlery” and “There exists a knife”. However, with the top-drawer scenario, there is a sense in which the conclusion that there exists a piece of steak-cutlery depends on the evidence that there exists a knife in a way that is not true of the bottom drawer scenario. This is, very roughly, the idea of “evidential dependence”. Of a set of evidence, does every subset establishing one conclusion also establish the other?

In scenario two, for instance, there is a subset of the overall evidence – the observation of the fork – that establishes that there exists a piece of steak-cutlery even if we were to remove/ignore the evidence establishing that there exists a knife. Hence in the bottom-drawer scenario “There exists a piece of steak-cutlery” is not evidentially dependent on “There exists a knife”.

This idea will be set out more precisely subsequently, but one immediate complaint sparked by this illustrative example would be: so what? We can capture the difference between the scenarios simply by the fact that the observation statement referring to the bottom drawer entails “There exists a non-knife piece of steak-cutlery” whereas the statement referring to the top drawer does not.

This is true of most cases: the idea of “evidential dependence” really is normally redundant. But it is possible for there to be scenarios where the entailments of a statement of what the evidence establishes will not distinguish distinct grounds we might have for accepting that statement. These cases have the following logical structure. Take any three propositions – P, Q, R – that could be included in a statement of what the evidence establishes (or could be entailed by an observation statement) whereby: (i) no proposition singularly logically entails any of the others (it is not that

² Or we could simply include the predicate “being in the top drawer” and add this to the referenced object’s properties.

$P \rightarrow R$ etc.); and (ii) $(P \& Q) \rightarrow R$ and $(P \& R) \rightarrow Q$; and (iii) $((\neg P) \& R) \rightarrow \neg Q$. Take the following two different scenarios where each captures all the relevant evidence:

- A. We have evidence that P, and we have separate evidence that Q.
- B. We have evidence that P, and we have separate evidence that R.

A standard observation statement of scenario A will be “P&Q”. A similar observation statement of scenario B will be “P&R”. These are different evidential scenarios. The observation statements, however, are mutual entailments and obviously have identical entailments. It is in principle possible that statements of what a body of evidence establishes will not distinguish which of several distinct evidential scenarios obtained: in this case, for instance, whether every sub-set of the evidence currently sufficient to establish that Q also establishes that P (in scenario A, no; in scenario B, yes).

One thought might be that this could not hold in practice. This seems false. Imagine a farm run by two friends who split the legal ownership of the cows: all male black cows and all non-male non-black cows belong to Sarah and are branded as such, the rest belong to Karen. Every cow on the farm thus occupies one of the four positions of this table:

	Male	Not-male
Black	Sarah	Not-Sarah
Not-black	Not-Sarah	Sarah

Imagine two possible evidential scenarios. In “Scenario1” you walk past a paddock, see there is a male cow in it and walking closer see that it is black (you cannot see its branding). Because of this evidence you would justifiably conclude it’s a black male cow. In “Scenario2” you walk past a paddock, see a male cow in it and see that it is Sarah’s (you can’t at this distance identify its colour). As a result of this evidence you would justifiably conclude the cow is male and Sarah’s. It is trivial to formally express what we know about each scenario in a predicate logic statement. If Cx : x is a cow; Mx : x is male; Bx : x is black; Sx : x belongs to Sarah; and where $\forall x[(Sx \& Cx) \rightarrow ((Bx \& Mx) \vee (\neg Bx \& \neg Mx))]$ ³, then:

Scenario1: $\exists x[Cx \& Bx \& Mx]$ (“There exists a cow that is black and male”)

Scenario2: $\exists x[Cx \& Mx \& Sx]$ (“There exists a cow that is male and Sarah’s”)

³ This last proposition could be understood either as a feature of background knowledge, or alternatively as a logical identity, this depending on how the earlier definition of ownership is understood. I will assume the latter in what follows, but the substance of the argument doesn’t depend upon it.

Scenario1 and Scenario2 represent different evidential situations. In Scenario1 you have evidence of the cow's maleness and separate evidence of its blackness, with the combination of this evidence necessary to conclude the cow belongs to Sarah. In Scenario2 you have evidence of the cow's maleness and separate evidence that it belongs to Sarah, with the combination necessary to conclude it is black. Yet obviously as observation statements the conclusions are mutual entailments: $\exists x[Cx \ \& \ Bx \ \& \ Mx] \leftrightarrow \exists x[Cx \ \& \ Mx \ \& \ Sx]$. Importantly, in both scenarios the empiricist baseline statement will entail both "there exists a black cow" and "there exists a cow belonging to Sarah". But in Scenario1 the evidence for the first was necessary to establish the second. In Scenario2 it was not.

This isn't a problem in the philosophy of perception, that we see the cow blackly but don't see it "Sarah-ly", the alleged qualitative distinction perhaps drawing on a restricted "adverbial" theory⁴. Even if this claim about perception is true, this doesn't for instance capture that in Scenario1 the blackness is the separately-evidenced predicate, and in Scenario2 it's not. The idea of separate/non-separate justifying evidential sets neither requires nor entails the correctness of a specific theory in the philosophy of perception⁵.

This difference in scenarios also is not based upon a difference in predicate nature or any particular predicate being privileged in principle. What separates these scenarios is a *contingent* fact about the evidence. To illustrate: imagine in Scenario2 you then approach the cow and see it is black. Now, by contrast, each predicate is separately evidenced, and this is a further different set of evidential relations – even though again the observation report will be a mutual entailment of each of the others.

What we seem to require instead is to identify and capture the presence or absence of the following relationship:

*Evidential Dependence*⁶: Proposition A is currently evidentially dependent on proposition B iff there is no sub-set of the evidential set that establishes that A without establishing that B, and the overall set establishes that A and that B.

⁴ Such as whereby sometimes "visual experiences are not episodes of sensing sense data but are rather episodes of sensing *in particular ways*" Fish (2010, p36).

⁵ Unsurprisingly, as it is orthogonal to arguably the most prominent motivations for developing theories of perception, that we want to distinguish between actual perception and hallucination, and that we want to know when we are justified in believing our perceptions (Smith 2002).

⁶ The use of the term "dependence" might suggest to a casual reader that there is some intended link to either a dependence logic or Cambridge dependence. There isn't: these are different things responding to different problems with different tools.

In other words, is the evidence establishing that B necessary to establish that A or do we have some *other* evidence that does so?

There are two claims in here perhaps worth immediately flagging as one is necessary for the substantive idea to be of use, the other capable of easy amendment. The necessary claim is that we can meaningfully think of a set and thus a subset of *pieces* of evidence. This is such an established feature of much of the actual practice of scientific endeavor that its rejection would be relatively radical, but there could be solipsist views that did so, or indeed one could think of a time-slicing view of epistemic agents where one simply knows everything at once without being able to recall how one gained knowledge of the propositions. These views would seemingly need to be rejected for evidential dependence to both sometimes obtain and be useful.

The easily amendable claim is that propositions are “established by some pieces of evidence”. Different theories of perception might frame this differently, such that it is sense-data that establish a proposition, or it is adverbial perceptive engagement that does so. Although I have phrased evidential dependence in terms of what the evidence establishes this can be rephrased and is not meant to substantively commit one to a particular evidentialist theory. So, if desired, one could rephrase the definition of evidential dependence and replace the idea of conclusions being established by different sets of evidence with that of conclusions being established by different sets of sense-data or by different sets of adverbial perceptive engagement or by any or each of these in combination with certain non-evidentially justifiably accepted propositions. The overall idea really only requires that we be able to distinguish if one premise entailed by a baseline empiricist statement is justified by all of the sets of pieces of evidence / sense data / adverbial perceptive engagements that are currently sufficient to establish a different premise.

Since it will be subsequently useful to succinctly express evidential dependence formally: let $\text{Evi}(P//Q)$ be read as “The evidence that P depends on the evidence that Q” and hold iff P is currently evidentially dependent on Q. One way this can be intuitively verified is by seeing if uncertainty as to our evidence that Q should justify uncertainty as to P⁷. For an evidential set that establishes that P, let the absence of this relationship (non-dependence) be $\text{Evi}(P\text{---}/Q)$, where this is read as “The evidence that P does not depend on the evidence that Q” and represent that “There is a subset of the evidential set that establishes that P but does not establish that Q”. Let $\text{Evi}(R)$ be “evidence exists that establishes that R”.

⁷ Although a sort of counterfactual uncertainty test is one way to check the dependence relationship holds, the relationship does not depend on a counterfactual. It is a fact about the relations between the sets of current evidence justifying two conclusions and whether one is a sub-set of the other, or neither.

As such we can easily express a key evidential difference between the cow scenarios:

Scenario1: $Evi(\exists x[Cx \ \& \ Sx] \ // \ \exists x[Cx \ \& \ Mx])$ ("The evidence that there exists a cow belonging to Sarah depends upon the evidence that there exists a cow that is male")

Scenario2: $Evi(\exists x[Cx \ \& \ Sx] \ \neg// \ \exists x[Cx \ \& \ Mx])$ ("The evidence that there exists a cow belonging to Sarah does not depend upon the evidence that there exists a cow that is male.")

The cow-based illustrative example is somewhat contrived, tellingly. Usually we naturally describe evidential scenarios using evidential facts that are independent, so that observation reports are normally phrased most simply as a series of separately evidenced claims. But nothing in propositional logic determines this need be the case, and it's possible to create hypotheses that inappropriately co-join independently-evidenced facts. This is exactly what happens with generalizations of grue-like predicates.

3 "Problematic" predicates and confirmation

3.1 A basic case

Consider the following very simple condition drawing somewhat upon Hempel⁸.

(neo) Hempelian Confirmation Condition 1 (HCC1):

E confirms H - where H is $\forall x(Fx \rightarrow Gx)$ - if:

- (i) E and H are co-possible;
- (ii) $E \rightarrow \exists x[Fx \ \& \ Gx]$

And following Goodman 1946, 1955 (where "<T" represents "exists before T", ">T" represents "exists at or after T", and T is some specified future date).

x is green₁ iff (x is green & <T) or (x is green & >T).

x is grue₁ iff (x is green & <T) or (x is blue & >T)

The observation statement that "there exists a green emerald before T" ($\exists x[\text{emerald}(x) \ \& \ <T(x) \ \& \ \text{green}(x)]$) would under HCC1 confirm both ($\forall x(\text{emerald}x \rightarrow \text{grue}_1x)$) (All

⁸ This encapsulates Nicod's Condition but with an expansion to cover bodies of evidence, one possible variant of Hempel's "satisfaction criterion of confirmation" (see Hempel 1965, p37). I do not mean to imply that he was committed to this: it is however recognizably neo-Hempelien.

emeralds are grue1) and “ $\forall x(\text{emerald}x \rightarrow \text{green}1x)$ ” (All emeralds are green1). This is the – famous - problem.

If we think of this in terms of evidential dependence, however, then it’s possible to see how “ $\forall x(\text{emerald}x \rightarrow \text{grue}1x)$ ” has taken two evidentially independent facts – that there is a green emerald and that it is before T - and made their co-presence necessary to having the hypothesis confirmed. After all, we have evidence that establishes the emerald’s existence and appearance (we see it, think we are not visually deceived etc.). And we have *separate* evidence that allows us to conclude it is before T (we see the calendar, we don’t think we have been asleep for a few decades or subject to time travel etc.). Expressed as an observation statement it is not possible to formally identify this as the following logical symmetry holds: $\exists x[\text{emerald}(x) \ \& \ <T(x) \ \& \ \text{grue}1(x)] \leftrightarrow \exists x[\text{emerald}(x) \ \& \ <T(x) \ \& \ \text{green}1(x)]$.

There is a key difference however: the evidence establishing that the emerald was observed before time T is currently necessary to establish that it is a grue1 emerald, the same is not true for establishing it is a green1 emerald. To pick up on this difference we can change HCC1 to the following:

(neo) Hempelian Confirmation Condition 2 (HCC2)⁹:

E confirms H - where H is $\forall x(Fx \rightarrow Gx)$ - if

1. E and H are co-possible.
2. $E \rightarrow \exists x[Fx \ \& \ Gx]$.
3. For all R such that $E \rightarrow \exists x[Fx \ \& \ Gx \ \& \ Rx]$ (and where $\text{Evi}(\exists y[Fy \ \& \ Gy \ \& \ (\neg R)y])$ is possible¹⁰), then $\text{Evi}(\exists x[Fx \ \& \ Gx] \neg / \exists x[Fx \ \& \ Rx])$.

The underlying idea here is that if we have evidence that an object that is F is both G and R, then generalizing that “All F are G” is to implicitly generalize to possible instances of Fs that are not-R. If the evidence that the object was R was however necessary to conclude it was G then this is ruled out. So if on the 10th of November we observe a grey goose and generalize that “All geese are grey” then we are implicitly confirming that a goose, if seen a few days later, will be grey. This – under HCC2 – is a valid generalization so long as the evidence that it is the 10th of November (our observation of our calendar, evidence of its reliability etc.) is not required to conclude it

⁹ I do not mean to endorse this condition, rather to use it to illustrate how evidential dependence can be used to address grue-like problems even in an incredibly simple neo-Hempelien framework.

¹⁰ The clause that “ $\text{Evi}(\exists y[Fy \ \& \ Gy \ \& \ (\neg R)y])$ is possible” rules out those cases where G logically entails R and also any case where it would be impossible to have evidence of something (imagine R is some predicate such as “for which we have evidence”).

is a grey goose, even if we do accept it is a grey goose that exists on the 10th of November¹¹.

By contrast, under HCC2, a green emerald observed before T will not confirm “All emeralds are grue1” as:

$\text{Evi}(\exists x[\text{emerald}(x) \ \& \ \text{grue1}(x)] \ // \ \exists x[\text{emerald}(x) \ \& \ <T(x)])$ “The evidence that an emerald that exists was grue1 depends on the evidence that the emerald exists before T”

“All emeralds are green1”, by contrast, is confirmed, with the analogous case to above being:

$\text{Evi}(\exists x[\text{emerald}(x) \ \& \ \text{green1}(x)] \ \neg // \ \exists x[\text{emerald}(x) \ \& \ <T(x)])$ “The evidence that an emerald that exists was green1 does not depend on the evidence that it is before T”

Note that this resolution does not rely on asserting any difference in principle between the status of green1 and grue1 – both are perfectly valid predicates. Nor does it rely on any claimed logical asymmetry between the hypotheses and the observation statement – *every single* logical relationship between “All emeralds are green1” and “There exists a green1 emerald” holds too between “All emeralds are grue1” and “There exists a grue1 emerald”. This is after all the point: the logical relations between the premises are identical. It’s the different evidential grounds for accepting the existence statements that vary. To accept “There exists a grue1 emerald” you require those bits of evidence necessary to establish that it is before T (seeing the clock, the calendar etc.). To accept “There exists a green1 emerald” you do not. It is the evidential dependence that is different given the evidence we have.

How then might someone deny this resolution? One option would be to deny the meaningfulness or possibility of evidential dependence – whether via solipsist or time-slicing theories. Or in principle one could reject the general difference between necessary and sufficient conditions (of some evidentially-established premise). I take it (almost) no one would want to claim that.

¹¹ Now, obviously, it is trivially easy to invent *further* evidence that might undermine or qualify the conclusion – such as that if someone is going to eat geese near Thanksgiving then it’s traditional to eat geese of different colours, so seeing a grey goose in November suggests it might have escaped from a mixed-colour geese farm, and thus maybe not all geese are grey. This is a secondary question however: the initial problem is over what should be concluded absent this further evidence.

A different sort of skepticism might try to break the evidential asymmetry between *green1* and *grue1* by claiming that we require the evidence that it is before *T* – such as seeing our watch or the calendar – to know the emerald is *green1*. The problem here is simply that this seems straightforwardly false: even if I was confused about what day it was I still have the evidence that the emerald is *green1*.

A fourth more promising option seems to be to hold that while the resolution gets *this* case right it might get some other ones wrong. While it's hard to guard against every such possibility, in what follows I run through what have been the most historically prominent variations / allied predicates. The resolution is robust to these.

3.2 *Observed-before-T status*

This result does not depend at all on indexing on time alone (rather than also say observational status – the *grue* paradox comes in multiple variants). Here, for example, is what Jackson (1975, p118) has argued is the truly problematic definition:

x is *grue2* at *t* iff (*x* is examined by *T* & *x* is green at *t*) or (*x* is not examined by *T* & *x* is blue at *t*)
x is *green2* at *t* iff (*x* is examined by *T* & *x* is green at *t*) or (*x* is not examined by *T* & *x* is green at *t*).

This reformulation creates no special new problems for HCC2:

$Evi(\exists x[\text{emerald}(x) \ \& \ \text{grue2}(x)] \ // \ \exists x[\text{emerald}(x) \ \& \ \text{examined by } T(x)])$ “The evidence that an emerald that exists was *grue2* is dependent on the evidence that the emerald was examined by *T*”

$Evi(\exists x[\text{emerald}(x) \ \& \ \text{green2}(x)] \ \neg // \ \exists x[\text{emerald}(x) \ \& \ \text{examined by } T(x)])$ “The evidence that an emerald that exists was *green2* is not dependent on the evidence that the emerald was examined by *T*”

3.3 *Observed status simpliciter*

Standard treatments of *grue* index on some time *T*, differing as to how to do so, either that (i) an emerald is *grue* iff it is green before *T* or blue at or after *T*, or alternatively (ii) that it is *grue* iff it is green at *t* and examined before *T* or blue at *t* and not examined before *T*. However, someone might think that an evidential-fact based resolution could face difficulties if we index on observation status / examined status *simpliciter*, *without referencing time at all*. That is:

x is *grue3* iff (*x* is observed & *x* is green) or (*x* is not observed & *x* is blue).

x is green3 iff (x is observed & x is green) or (x is not observed & x is green).

The cases here fall into two camps, depending on how “ x is observed” is specified. If being observed is solely equivalent to there being evidence that the object exists - that $\text{Evi}(\exists x) \leftrightarrow \text{observed}(x)$ - then both $\text{Evi}(\exists x[\text{emerald}(x) \ \& \ \text{grue3}(x) \ \& \ \neg \text{observed}(x)])$ and $\text{Evi}(\exists x[\text{emerald}(x) \ \& \ \text{green3}(x) \ \& \ \neg \text{observed}(x)])$ are impossible. If so, “All emeralds are grue3” and “All emeralds are green3” would be confirmed by an observed green emerald. But this is not a problem. “All emeralds are grue3” would entail that if we have any evidence that an emerald exists then we should believe that it is green. If we have no evidence that an emerald exists then we should believe *that the non-existing object is blue* (and green). Things that don’t exist would, under this suggestion, standardly be both blue and green¹².

Alternatively, assume “ x is observed” means something like “ x exists and x is part of our particular sample”. If so, this case will be analogous to grue1/green1 and grue2/green2 (simply swap the respective predicates “ $<T$ ” and “examined by T ” with “part of our sample” in the respective evidential fact statements).

The term “observed” admits of a certain ambiguity. But it poses no special problem so long as we are clear which holds: (i) $\text{observed}(x) \leftrightarrow \text{Evi}(\exists x)$ where x being observed simply means having evidence that x exists; or (ii) $\text{observed}(x) \leftrightarrow \text{Evi}(\exists xPx)$ where x being observed means having evidence both that x exists and that it has some other evidenced property “ P ” independent of mere existence.

3.4 Bleen and Grue

The result does not depend at all on privileging green/blue over grue/bleen. Let the following hold (where “ OT ” is a placeholder for any of the variants, “observed by T ”, “observed at t before T ”, “examined before T ”, “in our sample” etc...):

x is bleen iff (x is blue & OT) or (x is green & not OT)

x is grue iff (x is green & OT) or (x is blue & not OT)

Defining green4 and grue 4 solely in grue/bleen terms:

x is green4 iff (x is grue & OT) or (x is bleen & not OT)

x is grue4 iff (x is grue & OT) or (x is grue & not OT)

¹² There are lots of interesting wrinkles here, depending on when and if predicates attach to empty names. However, they are not really grue issues and can be defined away if desired. Ideally though HCC2 would come with an account of whether the predicates it covers require existence.

" $\forall x(\text{emerald}x \rightarrow \text{grue}4x)$ " is not confirmed by the observation of a grue4 emerald that is OT, whereas " $\forall x(\text{emerald}x \rightarrow \text{green}4x)$ " is confirmed.

$\text{Evi}(\exists x[\text{emerald}(x) \ \& \ \text{grue}4(x)] \ // \ \exists x[\text{emerald}(x) \ \& \ \text{OT}(x)])$ "The evidence that an emerald that exists was grue4 is dependent of the evidence that it was observed before T"

$\text{Evi}(\exists x[\text{emerald}(x) \ \& \ \text{green}4(x)] \ \neg // \ \exists x[\text{emerald}(x) \ \& \ \text{OT}(x)])$ "The evidence that an emerald that exists was green4 is not dependent on the evidence that it was observed before T"

To establish that the emerald is grue4 (and not bleen and OT) you need the evidence establishing that it is OT. Whereas to establish that the emerald is green4 you don't: the evidence of its appearance is sufficient to establish that it's either (grue and OT) or (bleen and not-OT), and as such either way it's therefore green4.

3.5 Overcoming the problems of the rival counterfactual approach

An evidential-dependence based solution enjoys advantages over the type of approaches first proposed by Jackson whereby an inductive straight rule is only applied for instances that meet a "counterfactual condition". For Jackson (1975, p124), this is:

"that the conjunction of certain Fs which are H being G with these Fs being such that if they had not been H, they would not have been G, does not support other non-H Fs being G".

What this means in practice is that the inductive projection from a "blah" emerald examined before T to the conclusion that other unexamined emeralds are "blah" is valid if the following counterfactual holds: that if the emerald *hadn't* been examined it would still have been "blah". Jackson (ibid, p124) then argues that we can know this in the emerald case with respect to greenness but not grueness (where unexamined emeralds are blue): "The emeralds we have examined are green not because they have been examined but because of their chemical composition and crystalline structure, and so, like most objects in our world, they would have had the colour they do have whether or not they had been examined". His later reformulation with Pargetter (Jackson & Pargetter 1980) qualified this slightly, making the counterfactual that if the F's had not been H they would still have been F and G.

As well as the question of whether such a move really covers all the key cases (Chihara 1981), this entire approach relies on the justification of the counter-factual. Jackson (1975 p129) tries to pre-empt this concern by arguing that while

counterfactuals “raise some of the most difficult problems in philosophy” it still remains that “we do, on occasion, know with certainty that certain counterfactuals are true, despite the difficulties in analyzing just what it is that we know on such occasions and how we know it”.

The worry, however, isn't just that a full theory of counterfactuals is difficult, it's that to produce the relevant conclusion – that unexamined emeralds would be green and not grue – we have to assume that some things (chemical composition / crystalline structure) are projectable in the relevant way, but why this is justified is exactly the issue at hand. As Roskies (2008) argues: “the problem with Jackson's solution to the grue paradox is that application of his counterfactual condition requires appeal to knowledge that application of the condition is supposed to justify. This is a pernicious form of circularity, in the absence of independent arguments to shore up our intuitions that greenness with respect to observation is counterfactually robust whereas grueness is not”¹³.

By contrast, a resolution relying on evidential dependence doesn't depend on any theory of counter-factual non-examination at all: it simply depends on the structure of the set of evidence we have. Whatever you think about what might have been, *there is a fact of the matter as to whether, of any particular set of evidence, there's a subset that justifies that P but doesn't justify that Q, in cases where the overall set of evidence justifies both propositions.*

Really all the evidential-dependence based approach requires is that pieces of evidence can be independent of each other, in the sense that it's possible to meaningfully think of a sub-set of a set of evidence (or a sub-set of sense-data or of adverbial engagements, depending on one's theory of evidence/perception). There's no need to appeal to what might have been had history been relevantly different and various objects not been observed.

3.6 Emerose cases

A prominent further proposed problem for counterfactual accounts is that of “emerose” predicates, such as in Godfrey-Smith (2003):

emerose1: An object is *emerose1* iff (an emerald at t & observed by T) or (a rose at t & not-observed by T)¹⁴.

¹³ A recent attempt to overcome these difficulties is Schramm 2014, and for a careful reworking of the relevant worries to apply to this effort see Dorst 2016.

¹⁴ Godfrey-Smith uses the symbol “O” to represent Jackson's “at t and observed by T” as well as other formulations “in our sample” etc. However, as this admits of being interpreted as “observed” simpliciter, absent time reference, the more precise formulation is included here (and on observation simpliciter see the earlier discussion)

emerose2: An object is *emerose2* iff (an emerald) or (a rose at *t* & not-observed by *T*).

The difficulty for counterfactual approaches is that “All *emerose1* are green” appears confirmed by an observed by *T* green emerald even with a counterfactual condition, namely that had the *emerose1* not been observed it would have still been green at *t*¹⁵. In the second case, the counterfactual is that had the *emerose2* not been observed it would have still been *emerose2* and green, so “All *emerose2* are green” is once again confirmed by a green emerald.

The HCC2 by contrast deals with these straightforwardly. “All *emerose1* are green” is not confirmed by an *emerose1* that is green (i.e. an observed by *T* green emerald) because the evidence that it is a green *emerose1* depends on the evidence that it is an *emerose1* *observed by T* (without the evidence that it is observed before *T* you wouldn’t have sufficient evidence to conclude it was *emerose1*). That is:

$$\text{Evi}(\exists x[\text{emerose1}(x) \ \& \ \text{green}(x)] \ // \ \exists x[\text{emerose1}(x) \ \& \ \text{observed by } T(x)])$$

With *emerose2*, the hypothesis “All *emerose2* are green” is not confirmed by a green *emerose2* (a green emerald) because the evidence that it is an *emerose2* that is green depends on the evidence that it is a green emerald.

$$\text{Evi}(\exists x[\text{emerose2}(x) \ \& \ \text{green}(x)] \ // \ \exists x[\text{green}(x) \ \& \ \text{emerald}(x)])$$

Because it is perfectly possible to have evidence of a green *emerose2* that is not a green emerald, the evidential dependence rules out the generalization¹⁶.

4. Why is this the right approach?

¹⁵ As noted, Jackson (along with Pargetter’s, 1980) reformulation of the earlier proposal does overcome *emerose1*-like cases, but hence *emerose2* in Godfrey-Smith (2003).

¹⁶ In the extant literature, having “All *emerose2* are green” confirmed by a green emerald is taken as self-evidently a bad-confirmation, so the HCC2 provides what most people will regard as the right result. I’m personally not sure if confirmation here is quite so straightforwardly problematic. There is a case that a non-rose should leave us skeptical about the existence of roses, thus the confirmation should depend on whether the body of evidence contains any non-green roses. However, in the context of *grue*-style problems the overall point remains: that simply encoding evidential dependence provides the resources to easily distinguish *grue*/*emerose* cases from green/emerald like ones.

That this result is possible and gets the cases “correct” is clearly significant, though the ingenuity of coining *emeroses* suggests that the HCC2 might need future revision to deal with an as yet not suggested case.

The general approach though has certain advantages over rivals, advantages that are likely to endure, and those that draw upon an underlying logic. Firstly, it doesn’t need us to establish that any predicate is in principle projectable, with all the associated worries that we have simply defined things to get the intuitive outcomes.

Secondly, it does not rely – as per the counterfactual approach – on us establishing what things would have been like had the relevant object not been observed, with the attendant worry that we again have assumed what is meant to be established. There is a fact of the matter as to whether one of two evidential sets is a subset of the other or not, and it requires no appeal to what might have been.

Thirdly, it does not rely – as per Godfrey Smith’s (2003) reframing of the problem as similar to that of confounding variables – on establishing a causal relation or its absence (so that we try to establish whether the object’s being observed caused its greenness). All the solution of this paper relies upon is the structure of the evidence and that alone. We need no background assumptions about causal relationships for the same reason we need no appeal to counterfactuals: the evidence tells us when a predicate is projectable or not.

This result also, however, seems to make sense for the right reasons, and further may hint at a broader justification. When we inductively generalize from evidence of a type of object having a particular predicate to all such objects we generalize to objects that have different features. If we see a green emerald on a Thursday and use this to confirm “All emeralds are green” then we have implicitly generalized to other green emeralds that might be seen on a Friday. This wouldn’t be justified if the evidence establishing that it was Thursday was a necessary part of the extant evidence sufficient to establish that there’s a green emerald.

This is what *grue*-like generalizations get wrong. Any set of extant evidence establishing that the emerald is *grue* has to contain the evidence to establish it is “before T” (or “observed at t before T” or whatever relevantly distinguishes *grueness* from *greenness-unrestricted*). And thus generalizing to situations where this evidence wouldn’t obtain – after T – is illegitimate (as long as other instances exist, as Jackson echoing Goodman always emphasized).

The underlying idea here is that our overall inductive generalizations should track the underlying structure of the logical relations between the justifying evidence. An instance of predicate P that also is predicate Q should be projectable to other potential instances with predicate not-Q iff the evidence that the instance was Q was not necessary to concluding that it was P. It is the contingent structure of the current evidential set that is necessary to identify this, not the logical relations between the predicates themselves.

A baseline statement of what a body of evidence establishes is not necessarily rich enough to capture all the relevant relations within the evidential set. This creates problems with ruling out the generalizing of predicates – such as *grue* – where one independently-evidenced fact is made inappropriately contingent upon another. These difficulties can potentially be overcome by formally encoding evidential dependence.

Acknowledgements I'm very grateful to Jonathan Cottrell and the reviewers for their helpful comments.

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